State of California

National Disaster Resilience Competition

Phase II
October 27, 2015

Attachment F: Benefit-Cost Analysis
AttFBCA.pdf

I. BCA PREPARATION PROCESS

The State of California, in partnership with GCR, Earth Economics, and the NDRC steering committee produced a benefit-cost analysis (BCA) of the Community and Watershed Resilience Program (CWRP). The CWRP is a resilience program designed to integrate forest and watershed health, local economic development, and community resilience in an environmentally- and economically-sustainable manner. The NDRC steering committee included: HCD, the Governor's Office of Planning and Research (OPR), the California Environmental Protection Agency (CalEPA), the California Department of Forestry and Fire Protection (CAL FIRE), U.S. Department of Agriculture Forest Service (USFS), the California Conservation Corps (CCC), and Tuolumne County. In addition, technical experts provided subject matter expertise to better refine inputs to the BCA. This group undertook the BCA to evaluate the cost-effectiveness of each of the three pillars of the CWRP (Forest and Watershed Health, Biomass Facility, and Community Resilience Centers) and the cost-effectiveness of the integrated program. The steering committee employed the structure identified in Appendix H, incorporating best practices in engineering, forest science, and social science to produce a comprehensive BCA for the application.

The steering committee solicited the expertise of Earth Economics to perform the BCA. Earth Economics completed an analysis of the economic impacts of the Rim Fire immediately following the event. Thus, Earth Economics has a strong foundation in recovery and resilience actions, and a sound understanding of the challenges of completing a BCA in a rural community that accounts for a broad suite of ecosystem services. Earth Economics' earlier analysis estimated that the environmental losses from the Rim Fire could be as high as $736 million.

Earth Economics and the steering committee (the Team) conducted meetings relative to each of the three pillars to identify exhaustive lists of the history of hazards associated with activities within each pillar, and summaries of avoided future costs, damages, and community and social benefits. The Team included the following personnel:

- HCD: Sue Naramore - Specialist
- OPR: Louise Bedsworth, PhD – Deputy Director
- CalEPA: Ashley Conrad-Saydah – Deputy Secretary, Climate Policy
- CAL FIRE: Dr. Helge Eng – Assistant Deputy Director for Resource Protection;
    - Kim Carr – Assistant Deputy Director of Climate and Energy
- Tuolumne County: Maureen Frank – Deputy Administrator
- California Conservation Corps: Erin Healy – Program Chief
- USFS: Barbara Drake – Director of Rim Fire Recovery;
    - Scott Tangenberg – Deputy Forest Supervisor;
    - Clare Long – Rim Fire Recovery Partnerships & Volunteer Coordinator
- GCR, Inc.: Seth Magden – Project Manager; Nathan Cataline – Senior Planner
- Earth Economics: Matt Chadsey – Project Leader; Rowan Schmidt – Project Leader

In addition to the above list of core Team members, additional personnel from within state and federal agencies, county departments, state and local emergency management, and collaborators (TSS Consultants) provided data and input.

II. PROPOSAL COST

The proposed budget for the State of California's NDRC Community and Watershed Resilience Program is $117 million, and the overall BCR is 1.53 with a discount rate of 7

percent. Supporting commitments from the USFS for activities that align with and support the State's Program total $18.7 million. The USFS activities will be completed parallel to and in support of the NDRC project schedule.

The BCA accounts for anticipated ongoing operations and maintenance costs associated with each activity, which are approximately 2.5 percent of capital/equipment costs for the Biomass Facility ($375K) over 30 years and 3 percent of capital facility/equipment costs for the Groveland and Tuolumne CRCs ($544K and $190K respectively) over 30 years. The ongoing revenue generating aspects of these facilities will accommodate the operations and maintenance costs; the County has committed to budgeting for ongoing upkeep as well. The simplified budget is presented below, with each activity identified, and the supporting documents used to develop the total project cost can be found here in the BCA Supporting Documents sections of the page.

Activity	Budget
Forest & Watershed Health	Sub-Total: $40M
Forest & Watershed Health	*$40,000,000*
Biomass Facility and Wood Products Campus	Sub-Total: $22M
Phase I	*$6,000,000*
Phase II	*$16,000,000*
Community Resilience Centers	Sub-Total: $55M
Groveland (CRC &CCC facility)	*$37,100,563*
Phase I	*$7,057,500*
Phase II	*$30,043,063*
Tuolumne City (CRC)	*$17,899,437*
Phase I	*$4,492,500*
Phase II	*$13,406,937*
Total Project Cost	**$117,000,000**

III. PROJECT CONTEXT AND CURRENT SITUATION

Community Overview

Tuolumne County is a rural county located in the foothills of the Sierra Nevada Mountains and is known as the "gateway to Yosemite National Park." The County is at the center of the Tuolumne Watershed, which provides water for the City and County of San Francisco and parts of the Central Valley, contributing to the sixty percent of California's water supply which originates in the Sierra Nevada region. The communities within Tuolumne County are primarily connected by winding and narrow two-lane roads, many of which traverse mountains, valleys and gorges. Tuolumne County has a large share of retirees and part-time residents, which somewhat distort the County LMI map. For example, over 52 percent of children in grades K-12 are on a free or reduced meal program (Tuolumne County Superintendent of Schools). Further, many full-time residents are over 60 (29.8 percent), representing 51 percent of households, and constituting a portion of the County's vulnerable population. The County has seen a decline in recent years of employment opportunities, as many of the historic larger employers in the region, such as saw mills and paper companies, have closed operations. Further, residents working in seasonal recreational employment have lost work due to the impacts of the Rim Fire.

The Rim Fire was the third largest wildfire in the State's history. However, the State has been experiencing more frequent large, intense wildfires in recent years due to the historic drought and changing climate. Therefore, California targeted the Community and Watershed Resilience Program (CWRP) in Tuolumne County for three reasons. First, the program is designed to meet the unmet recovery needs in the region – both within the community, but also the forest. Second, the Rim Fire recovery effort provides the opportunity to develop a pilot CWRP that may be

adaptively replicated throughout California and the Western United States. Finally, Tuolumne County's leadership and residents engaged heavily in the development of the CWRP; this engagement and interest will facilitate successful implementation of the program and ongoing interest in maintaining resilient practices.

Summary of Disaster Impacts

The 2013 Rim Fire burned over 250,000 acres in Tuolumne County. The fire destroyed forest, rangelands, tribal lands, public and private cabins and camps, and other forest and rangeland infrastructure – all of which are part of the critical upper watershed for the state's water supply. The majority of the burn area is in Stanislaus National Forest, but the fire also burned portions of Yosemite National Park, other publicly held lands, and private timber and ranching land. The fire burned for over two months, causing serious economic disruption to residents and local businesses. Smoke from the fire covered a wide area, posing public health risks to the local community and others in the region. This risk is of particular concern to children, the elderly, and the infirm.

Public Infrastructure: The Rim Fire destroyed permanent public infrastructure, including roadway systems that provide access in to and out of Stanislaus National Forest. The damage stems not only from direct fire impacts, but also from cascading and ongoing landscape changes due to the fire, such as erosion and landslides. The Rim Fire also destroyed rangelands, fencing, and water troughs that had been in use by cattle ranchers under long-term agreements with the USFS and prevented grazing in the forest. These fences are of particular importance as they insure that grazing cattle do not impact water sources or sensitive habitat.

Environmental Degradation Earth Economics estimated the environmental benefit losses from the Rim Fire to be in excess of $100 million, just in the first year following the event, based on

estimates of ecosystem services within the burn area before and after the fire (Earth Economics Rim Fire Report_11.27.2013 – page 25, 6. Conclusions). This estimate was calculated using a FEMA accepted and scientifically validated Benefit Transfer Methodology (Earth Economics Rim Fire Report_11.27.2013 – page 4 Preliminary Assessment). This methodology enables quantification of a range of benefits, including open space, public's willingness to pay for outdoor recreation, water quality, and to determine the costs incurred when healthy ecosystems are degraded. Looking only at the federal land burned, the USFS estimates the following environmental damage in the Forest (USFS Environmental Degradation Summary Report, amounts shown below do not include the infrastructure projects discussed under "Public Infrastructure"):

- Soil and Water: $3,639,375
- Heritage/Archeological: $3,054,752;
- Timber: $117,191,490
- Botanicals: $9,085,000
- Other Infrastructure: $1,493,520
- Recreation Revenue losses: $43,766,779
- **Total Environmental Damage on US Forest Land: $178,230,916**.

The damage from the Rim Fire has had long-lasting effects on the forests, local communities, and beyond. Local communities, whose economy is closely linked to the health of the forest through tourism, recreation, timber, and wood products, suffered from business loss and closure, direct public health impacts, and depressed property values. And, as discussed in more detail in Exhibit D, the effects on downstream water storage and supply and the long-term implications for carbon storage affect the entire state.

Existing Vulnerabilities

Risks to the State's Water System: Wildfires affect not only the communities and the natural and built environment in the immediate vicinity, but also the "downstream" watershed communities and cities who are also end-users of this water supply. The Tuolumne watershed is extensive, directly serving County residents and businesses, as well as downstream communities in the San Francisco Bay Area and the Central Valley. The Tuolumne watershed supplies the needs of 550,000 people within the watershed, 2.4 million people in the Bay Area, and irrigates more than 300,000 acres of prime agricultural land, and powers two hydropower systems (Mount 2010). Given that California is currently in a prolonged severe drought, with 5,433 residents without water in the Central Valley, the potential for catastrophe across the Tuolumne watershed is increasingly heightened.

Risks to the Local Community: These threats, hazards, and vulnerabilities are common in communities and watersheds across the Sierra Nevada region. Future risks from the threats, hazards, or vulnerabilities include the cumulative effects of repeated large, high intensity wildfires on local rural economies. Over time and large areas, impacts can include the elimination of resource based companies such as sawmills and contractors. Capacity for resilience and adaptation is strongly influenced by the size and diversity of a community's economic base.

Economically Fragile Area: Per current American Communities Survey (ACS) data, the census tract area has an unemployment rate of 15.4 percent, which is 158.4 percent of the national average of 9.7 percent CA NDRC Target Area Unemployment-Census Tracts.

Census Tract	Workforce	Employed Population	Unemployed (%)	MID-URN vs. Nat'l Avg.
06109002200	3342	2821	15.6%	160.8%
06109004100	2471	2121	14.1%	145.8%
06109003100	2140	1777	17.0%	174.8%
06109003200	2875	2435	15.3%	157.7%
06109004200	1487	1265	14.9%	153.9%
Burn + Evac Area	6501	5477	15.8%	162.5%
Burn + Evac + Evac Warning Area	12315	10419	15.4%	158.7%

Some additional key demographic figures are as follows:

- 29.8% of Tuolumne County's Population is over 60 years old
- 17.2% is under 18
- 18.4% of residents have a disability
- 12% have less than a high school diploma
- 8% have an associate's degree
- 12% have a bachelor degree
- 14.5% live in poverty

General Environmental Conditions

The Target Area has suffered prior environmental distress due to drought, previous wildfires, and overstocked forests. Most recently, the County has requested that Governor Edmund G.

Brown declare a State of Emergency due to the large number of dead and dying trees in the County. Tree mortality has been exacerbated by drought and beetle infestation. The dead and dying trees pose a hazard to life and safety, but also constitute an enormous fuel load for a future fire. Pre-Rim Fire tree mortality was high due to drought and associated disease, and possibly a changing climate. The dead and dying trees translated into large amounts of fuel, and set the stage for the Rim Fire.

The US Department of Agriculture and National Oceanic and Atmospheric Association's Drought Monitor Mitigation Map shows that Tuolumne County was under Moderate Drought conditions in August 2012 (August 14 2012 Drought Monitor Map). Four days before the start of the Rim Fire, a similar map shows that Tuolumne County was under Severe Drought (August 13, 2013 Drought Monitor Map). Currently, nearly 40 percent of California, including Tuolumne County, is under Exceptional Drought, the most severe drought ranking used (Current Drought Monitoring Map), and other than the highest peaks in Tuolumne County, the Target Area in Tuolumne County is and has consistently been under very high fire threat as shown by the California Fire Threat Map. This map is based on 2005 data, which does not include the current drought.

From a regional perspective, the Target Area has experienced regular wildfire events, as shown in the Tuolumne Burn History Map. The 1987 Complex Fire burned 157,000 acres in Tuolumne County, much of which was burned again in the Rim Fire. Natural regeneration of trees following wildfires that burn as hot the Complex and the Rim fires is often insufficient, resulting in type conversion from forest to grass and shrub lands, which are more susceptible to high severity fire and store substantially less carbon than healthy forests.

The conditions that contributed to the severity of the Rim Fire are common across California and much of the Western United States due to past fire exclusion, declines in timber harvesting and reduced forest management activities, and unnaturally dense forests. These conditions also degrade the quality of the watershed. Overstocked forests decrease the amount of water absorbed into the soil. In forests with high canopy density, comparatively larger amounts of rain and snow can be captured in the canopy and evaporate rather than making it to the ground and flowing into streams, rivers, and reservoirs (Bales et al. 2011). Current forest health and climate change is leading to more frequent and more severe wildfires (Quantitative Evidence for the Increasing Forest Fire Severity, Page 28).

IV. PROPOSED PROJECT DESCRIPTION

Key Objectives

Project Title: Community and Watershed Resilience Program (CWRP)

The key objectives of the proposed CWRP are to develop an economically- and environmentally-sustainable model for resilient watershed management in Tuolumne County that fosters social cohesion, and creates new economic opportunities associated with resource stewardship. The three integrated pillars of the program are:

1. Forest and Watershed Health: biomass removal, restoration, and reforestation activities in the Rim Fire burn area. Activities designed to improve forest and watershed health.
2. Integrated Biomass and Wood Products Facility: This facility will provide clean power, cooling and heating, and a wood products facility to utilize wood removed from the impacted disaster area. The facility will serve the Rim Fire recovery area, and act as a regional facility to accept thinned biomass from Tuolumne and surrounding counties.

3. Community Resilience Centers: Designed to increase community resilience, these facilities will provide a model for increasing community resilience through outreach and education programs and provide services during an emergency. These facilities will be a model for serving rural communities.

Each of these components increases resilience individually, but the collective actions of the CWRP provide an innovative, revenue-generating, scalable, and replicable pilot program that can serve myriad similar rural regions throughout the western United States.

Design Philosophy

The scientific basis to design a program to boost forest and watershed resilience is not a new discovery; the individual activities proposed to help design resilient communities are similarly well understood. The design innovation of the Community and Watershed Health Resilience Program (CWRP) lies in the interconnection the pillars of activity and in the move to overcome long-standing economic barriers to completing this work. The program is designed to intentionally link education and job training in the local community with forest and watershed health work. The biomass and wood products facility is intended to provide an economic driver for forest and watershed work, and also to provide new economic development in the community. Building the necessary infrastructure, institutions, and partnerships to connect these activities will ensure that the program is self-sustaining and more easily replicated in other communities.

The three interrelated pillars of the CWRP will have near, medium and long term recovery and resilience impacts. The Forest and Watershed Health work will begin immediately post-award, instituting strategic fuel breaks to protect human life and support ongoing work in the forest. The restoration, reforestation and biomass removal will contribute to reclaiming a healthy ecosystem

as well as mitigating fire risks. These efforts will have immediate impacts that will provide long-term ecosystem benefits. Following the initial phase of design and engineering and pre-development, the Biomass Facility and Community Resilience Centers will come online within approximately 14-24 months, and will also provide long-term multi-generational benefits for community recovery and reducing risks and vulnerabilities within the region. **Geographic Boundaries of Project and Service Areas**

The project activities will all be located within the Rim Fire burn area and the communities that were under mandatory evacuation orders and in evacuation warning areas. However, the service area naturally extends beyond the borders of the County. Because the forest and watershed are not confined by man-made borders demarcating county lines, the impacts of the forest and watershed work that is done in Tuolumne County will extend well beyond the County. As indicated, the Tuolumne Watershed provides water to the City and County of San Francisco, and is part of the critical backbone of the State's water system.

Anticipated Changes to Local Policies

There are numerous actions at the local, regional and State level being implemented which will enhance the proposed Program. The following examples have all been actions since the release of the NOFA – many in just the last month or two.

Executive Action

Executive Order B-30-15: Governor Brown issued Executive Order (EO) B-30-15 on April 29, 2015. EO B-30-15 established a 2030 greenhouse gas emission reduction target and a multi-part resilience program. This includes direction for state agencies to incorporate climate change into

all state planning investment, to prioritize the use of natural and green infrastructure, and to use full life cycle cost accounting in infrastructure planning decisions. OPR is leading a Technical Advisory Group to assist in the implementation of the Executive Order.

Legislative Actions

The following pieces of legislation were signed into law:

- **Senate Bill 246** (signed 10/8/15) creates the Integrated Climate Adaptation and Resilience Program within the Governor's Office of Planning and Research. The Program would serve as a clearinghouse for information on local and regional climate adaptation and resilience and serve as a liaison between local and regional programs and State agencies.
- **Senate Bill 350** (signed 10/7/15) increases renewable electricity procurement from 33 to 50 percent.
- **Senate Bill 379** (signed 10/8/15) requires local governments to address climate change in their local hazard mitigation plan or the Safety Element of their General Plan.
- **Assembly Bill 1482** (signed 10/8/15) requires the CA Natural Resources Agency to update the *Safeguarding California* Plan every three years, and directs the Strategic Growth Council to ensure that funding programs are consistent with *Safeguarding California*.

Raising Enforceable Standards

General Plan Guidelines Update: The Governor's Office of Planning and Research updated the *General Plan Guidelines (GPG).* The new GPG includes resources, data, tools, and model policies to help cities and counties update their general plans and address climate change goals and adaptation. A public review draft of the GPG was released on October 12, 2015.

Plan Updates and Alignment

Tuolumne County Water Management Plan: City, county and water district management have strived for years to create a unified vision for water management in Tuolumne County. In 2013, the Board of Supervisors voted to resurrect the county water agency "to ensure adequate water suppliers to meet the diverse needs of a healthy and economically viable community." In November of 2014, decided that outside professional facilitation would be necessary to move the initiative forward. The goal is to discuss the hydrologic changes currently occurring in the county and to consider potential future changes and their impacts.

Tuolumne County General Plan Update: Tuolumne County is currently in the process of updating its General Plan Environmental Impact Report. The Final EIR will be available in December 2015, with public meetings occurring in December 2015/January 2016.

The activities proposed within this application align with the draft General Plan update including the Economic Development, Natural Resources, Water Resources and Public Facilities Elements.

- Economic Development: commitment to align County resources with agencies providing job training and business development for the Central Sierra Nevada region
- Natural Resource: support biomass energy facilities, manage invasive plants and vegetation removal for fuel reduction, and balance conservation with fire hazard reduction.
- Water Resource: Align goals with climate adaptation strategies at the state level, support water harvesting and storage, develop policies and programs to adapt to extreme climate effects such as drought and flooding.

***Safeguarding California* – Implementation Action Plans:** A 2014 supplement to California's 2009 Climate Adaptation Strategy implemented through the California Natural Resources

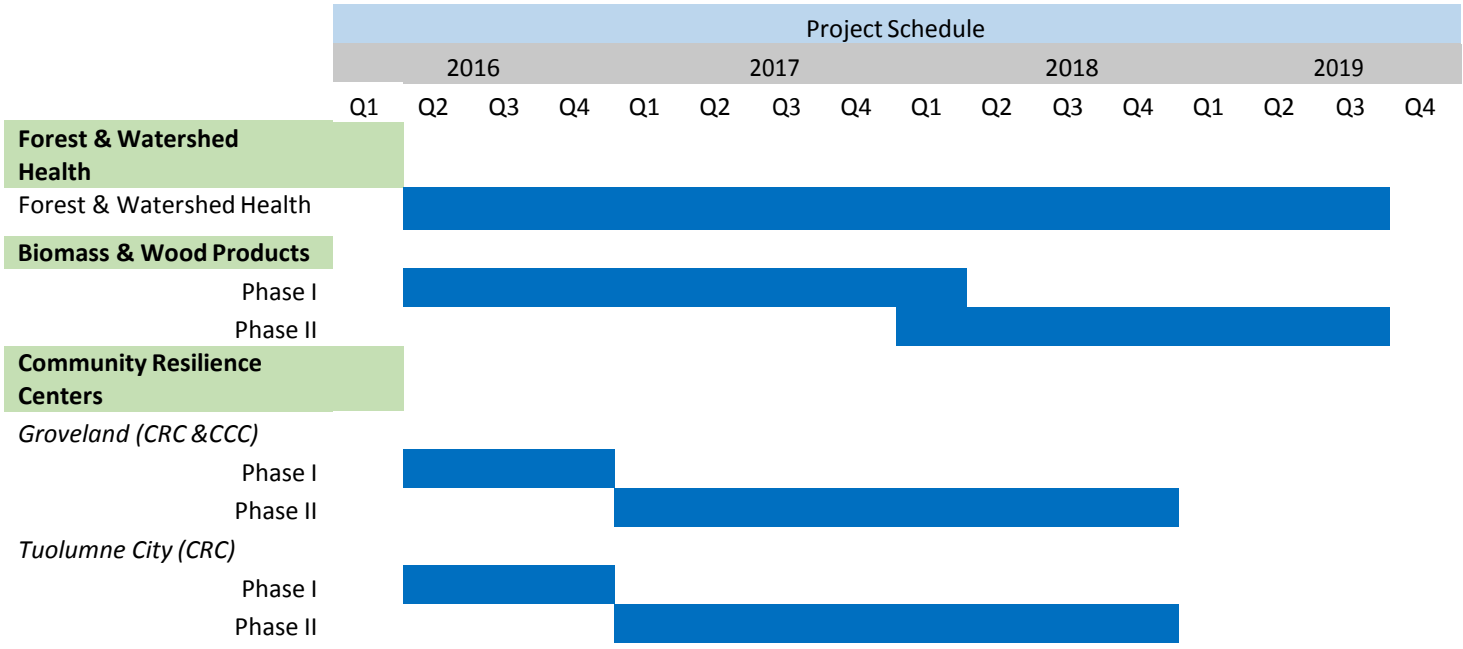
Agency and one of the main pillars of California's climate change strategy. Implementation Action Plans have been developed for each sector and were release for public comment in October 2015.

Assembly Bill (AB) 32 Scoping Plan: The California Air Resources Board (CARB) launched a process to develop an updated plan for meeting the State's 2030 GHG emission reduction goals. This process will include developing a GHG emission reduction framework for natural and working lands. A kick-off workshop was held on October 1, 2015.

Forest Carbon Plan: An internal review draft of the Forest Carbon plan is complete. A final draft will follow the release of the Scoping Plan update in late 2016.

Project Timeline

Pending award and action plan alignment in January, the State of California and its Partners are prepared to implement the Community and Watershed Resilience Program on the following timeline.



Estimated Useful Life of Proposal

For the purposes of calculating this BCA, the Team designated a 30-year design lifespan. However, it is important to note that environmental and ecosystem improvements in the forest and watershed can be expected to have a greater useful life.

Describe Reasoning around Any Alternative Discount Rate

The BCA used both 7 percent and 3 percent discount rates. Given the long-term, multi-generational nature of the investments being proposed, especially in the restoration of ecosystem services, a 3 percent discount rate would be reasonable to apply.

V. RISKS IF PROPOSAL IS NOT IMPLEMENTED

Future Risks

The current risks and vulnerabilities to Tuolumne County and the greater Sierra Nevada region are marked. California is currently in the middle of an extreme and prolonged drought, which coupled with the tree mortality epidemic throughout the State presents real and significant threats. Without action, the future risks will only be magnified. The next five years will be critical for forest and watershed restoration and reforestation in the burn area. If no action is taken, conditions will be ripe for catastrophic fire. In twenty years, the risk of intense, widespread wildfires increases exponentially without action in the first five years. With no action the situation would only be compounded at a fifty-year interval, although given historic wildfire recurrence intervals there is a strong probability that a wildfire would have already occurred, with the likely result further ecosystem devastation and threat to human life.

The attached Earth Economics Methods and Assumptions document outlines and presents calculations for "no action" and "with action" alternatives for each of the three Program areas. Below are high level narrative responses to illuminate the alternative scenarios with and without implementation of the proposed Program.

Alternatives to Forest and Watershed Health Activities

With no restoration work, the forests will remain in a degraded condition for the foreseeable future. Carbon storage and sequestration will be a fraction of the potential that can be realized in a healthy, growing mixed conifer forest in this area. In addition to the concerns noted above, this will also pose risks to biodiversity and broader ecosystem health. This will also threaten water supply for the local community and millions of downstream users.

Alternatives to a Biomass and Wood Products Campus

Without a biomass wood products facility, biomass will be piled and burned in the open. This will result in increased local and regional air pollution. Open burning also poses a risk of fire in the forest. The facility also provides a delivery point for residue cleared through the forest health activities, spurring ongoing investment in forest health after the completion of NDRC funding.

Alternatives to the CRCs

Without the CRCs, the community and broader region will lack facilities to provide centralized support to community members from Tuolumne County and its neighbors during an emergency. The community will also lack supportive services, better transportation options, and education and training for new economic opportunities. Without the CRC in Groveland, the CCC will not have a location to develop a locally based work crew to support the forest and watershed health work.

Community Impacts

As discussed above, the impacts of no action will be significant. An analysis of a neighboring watershed shows that without investments in forest health investments, the size and intensity of fire increases. The economic benefits of investments in forest and watershed health activities could be up to three times the cost of undertaking the work. State and federal government and private homeowners are the primary beneficiaries of these benefits. While the analysis above focused on fire suppression costs and ecosystem impacts, reduced fire risk should also result in lower levels of smoke exposure, which will also have important benefits for the local community.

Additive Benefits

The Community and Watershed Resilience Program is an interconnected set of activities that realizes multiple co-benefits across sectors. While each of the activities presented in this proposal will increase resilience in their own right, the integration of the three is the key to its broader success. Implementing work in each of the three areas will provide the opportunity to demonstrate how each of the elements can work with the other (e.g., job training feeding into forest and watershed health work; contracting needs for getting material from the forest and watershed work to a biomass facility). Understanding and demonstrating the mechanics of these interconnections will be invaluable for replication of this program in neighboring counties and the broader region.

Avoided Costs

The direct emergency response to the Rim Fire was $127 million, and the ecosystem losses and environmental damage estimates range up to $736 million. The BCA presented herein demonstrates that the proposed Program will have cumulative benefits across all three pillars of activity of $228,200,470. In performing benefit cost analysis, benefits equate to avoided future costs, or a reduction in future damages. The FEMA BCA Reference Guide defines benefits in this way, in that benefits equate to "future losses prevented or reduced by a mitigation project. The benefits counted in a BCA are the present value (in dollars) of the sum of the expected annual avoided damages over the project useful life." The table below, which is included in the full BCA spreadsheet produced by Earth Economics, demonstrates the present value of project benefits for each of the three activity areas.

Discount Rate = 7% Project Life = 30 Years	Forest & Watershed Health	Biomass & Wood Products	Community Resilience Center	TOTAL
Lifecycle Costs (2015 $)	$54,348,010	$73,330,800	$103,890,000	**$ 231,568,810**
Lifecycle Costs (Present Value)	$41,416,603	$38,182,459	$69,281,397	**$ 148,880,459**
Project Benefits (Present Value)	$134,984,276	$53,969,024	$39,247,170	**$ 228,200,470**
Net Present Value	$93,567,673	$15,786,565	$30,034,227	**$ 79,320,011**
Benefit Cost Ratio	**3.26**	**1.41**	**0.57**	**1.53**

VI. COSTS AND BENEFITS

The following data is presented here in the context of the narrative response of Attachment F, in accordance with the prompts of Appendix H. For a more contextualized review of the BCA data, and to review the full spreadsheets, calculations, methodologies, and extrapolated values, please refer to the attached spreadsheet and methodology statements.

Benefit Cost Ratio and Net Present Value

Discount Rate = 7% Project Life = 30 Years	Forest & Watershed Health	Biomass & Wood Products	Community Resilience Center	TOTAL
Net Present Value	$93,567,673	$15,786,565	$30,034,227	**$ 79,320,011**
Benefit Cost Ratio	**3.26**	**1.41**	**0.57**	**1.53**

Lifecycle costs

The condensed table below demonstrates the monetized benefits and lifecycle costs calculated for the Community and Watershed Resilience Program over a 30-year useful life, with a 7 percent discount rate. Also presented below is a second scenario of the Program over a 30-year useful life, but with a 3 percent discount rate. The 3 percent discount rate is seen as feasible for multi-generational ecosystem benefits, but for the purposes of adhering to the standards outlined in the NOFA, both are presented. The full detail, calculations and methodology can be reviewed in the attached spreadsheet.

Discount Rate = 7% Project Life = 30 Years	Monetized Benefits					Costs	Benefit Cost Ratio
	Resilience	Environmental	Social	Economic	Total Benefit	Lifecycle	
Forest & Watershed Health	$ 21,696,032	$ 91,746,249	$ 4,334,512	$ 17,207,484	$ 134,984,276	$ 41,416,603	3.26
Biomass & Wood Products	$ 174,494	$ 3,876,872	$ -	$ 49,917,658	$ 53,969,024	$ 38,182,459	1.41
Community Resilience Center	$ -	$ 630,055	$ 401,652	$ 38,215,464	$ 39,247,170	$ 69,281,397	0.57

VII. RISKS TO ONGOING BENEFITS

Uncertainties & Adaptability

The certainty factor was evaluated and calculated for each of the three activities, and this information is presented in the attached comprehensive BCA spreadsheet produced by Earth

Economics. Column J reflects the certainty value for each of the evaluated components, using the designated rating value 1-5 range.

As visible in the spreadsheet, there are numerous benefits for which there are no dollar values. Many of these have fairly high levels of certainty, but still remain challenging to quantify. This is true for some benefits of the forest and watershed work, including the impacts on insurance rates, impacts on cattle ranching, and habitat benefits. In each case, these are important benefits to the local community and the broader region.

These uncertainties become even more apparent for the Community Resilience Centers. It is known that there are benefits associated with increased access to specific services, but they are difficult to quantify. In some cases, these benefits may become clearer through the phase 1 design process, though they are likely to remain challenging to quantify. Furthermore, the analysis is not able to capture the enabling impact that local education and training opportunities through the CRCs will provide in completing the work in the other pillars. As a pilot program, these interdependencies will be captured and information should be available to inform the design of similar programs in other communities.

The Community and Watershed Resilience Program (CWRP) is a pilot that allows for both adaptation and expansion, as needed, to magnify actions in the forest and watershed, with the potential for increased capacity of the biomass facility depending on forest condition. Beyond the immediate target area, the CWRP is highly applicable and adaptable in neighboring counties and communities throughout the Sierra Nevada region. The challenges discussed here are not unique to Tuolumne County; similar forested mountain communities are common throughout the West, providing many opportunities for replicating this pilot program.

Additional Benefits not Included in BCA

The Earth Economics evaluation of the CWRP included an economic impact analysis, which calculated separately and was not factored into the BCA. The results of this economic impact analysis are presented in the attached spreadsheet (EIA Results) and methodology document (EIA methodology). This methodology document outlines the reasoning for keeping these values separate, in accordance with best practices and OMB standards.

While these economic benefit values were not included in the BCA, it is important to note that they represent significant positive impacts to the region over the course of the project and beyond. For example, the average annual economic impact of the program will realize a total value added of over $11 million for Tuolumne County. Some of the key data from the Earth Economics report is presented in the tables below, and the full report can be viewed in the EIA Results attachment.

Total 5-Year Economic Impact For Tuolumne County
(Note: This analysis does not Recognize $ that leave the County)

All Programs				
Economic Indicator	**Direct**	**Indirect**	**Induced**	**Total**
Employee Compensation	$16,580,048	$2,783,933	$3,880,510	$23,244,490
Proprietor Income	$11,046,712	$1,108,129	$716,114	$12,870,956
Other Property Income	$8,535,679	$3,169,492	$4,030,728	$15,735,899
Taxes	$774,693	$1,452,567	$1,874,569	$2,776,119
Total (Value Added)	$37,577,358	$8,216,614	$9,664,909	$55,458,880
Forest and Watershed Health Program				
Economic Indicator	**Direct**	**Indirect**	**Induced**	**Total**

Employee Compensation	$5,430,561	$330,673	$1,476,958	$7,238,192
Proprietor Income	$5,945,039	$339,780	$272,764	$6,557,583
Other Property Income	$4,495,054	$412,980	$1,531,943	$6,439,977
Taxes	$98,394	$395,901	$1,232,913	$401,499
Total (Value Added)	**$16,609,273**	**$1,181,827**	**$3,677,566**	**$21,468,665**

Biomass Facility Construction

Economic Indicator	Direct	Indirect	Induced	Total
Employee Compensation	$2,776,462	$620,750	$592,902	$3,990,113
Proprietor Income	$1,215,034	$189,956	$109,359	$1,514,349
Other Property Income	$1,431,498	$717,484	$616,450	$2,765,432
Taxes	$184,633	$292,838	$158,256	$635,727
Total (Value Added)	**$5,607,627**	**$1,821,028**	**$1,476,967**	**$8,905,622**

Groveland CRC Construction

Economic Indicator	Direct	Indirect	Induced	Total
Employee Compensation	$5,613,145	$1,226,525	$1,213,513	$8,053,183
Proprietor Income	$2,605,542	$387,135	$223,844	$3,216,521
Other Property Income	$1,749,118	$1,364,716	$1,261,557	$4,375,391
Taxes	$329,605	$511,193	$323,979	$1,164,777
Total (Value Added)	**$10,297,411**	**$3,489,569**	**$3,022,893**	**$16,809,872**

Tuolumne CRC Construction

Economic Indicator	Direct	Indirect	Induced	Total
Employee Compensation	$2,759,880	$605,985	$597,137	$3,963,002

Income	Proprietor Income	$1,281,097	$191,258	$110,147	$1,582,503
	Other Property	$860,009	$674,312	$620,778	$2,155,099
	Taxes	$162,061	$252,635	$159,421	$574,116
Added)	**Total (Value**	**$5,063,047**	**$1,724,190**	**$1,487,483**	**$8,274,721**

VIII. IMPLEMENTATION CHALLENGES

Political or Stakeholder Risks, Community Support for the Proposal

The California Team has obtained letters of support for the Program from representatives of the California Congressional delegation and Governor Edmund G. Brown. The Program was designed by key high level personnel from the relevant State and Federal agencies and County leadership, and with the input of numerous other state, regional and local groups. As such, the political risks of implementing the Program are very low. Failure to initiate action to confront the risks and vulnerabilities facing California would constitute greater political risk. At a stakeholder level, there has been tremendous support from within the community, evident at public meetings during the public comment period.

Technical, Procedural/Legal Risks, Consultation with Environmental Groups

The Program presented herein is an innovative, dynamic, and forward-thinking approach to addressing a set of problems that plague not only California, but much of the Western United States. As with any type of innovation, or departure from a "business as usual," there will be a period of community education and capacity building for all stakeholders. For example, the growth of small-scale biomass energy facilities in California represents a change from biomass electricity developments spurred by an energy crisis several decades ago. It will be important to work with stakeholders to provide ample understanding of the benefits of a series of smaller

facilities in areas adjacent to development. These facilities are designed to provision long-term forest health and sustainability and multiple community and economic objectives to maintain rural characteristics. Appropriate scaling and siting will require regular public consultation.

The California team has worked with two collaborators (TSS Consultants and Red Rock Biofuels) in developing the biomass facility component of this application. Through public meetings, residents and local groups such as the Tuolumne River Trust and Yosemite-Stanislaus Solutions provided valuable input about feasibility and project design. Pending award and following State procurement guidelines, the State will continue to engage technical and educational assistance from these or similar collaborative partners. A number of partnerships have been coalescing around forest and watershed health issues, providing additional venues for scoping this work. Some of these bring together unusual partners, such as the California Forest Watershed Alliance, which includes environmental groups, the timber industry, the farm bureau, water agencies, and advocates for rural counties. CalEPA and the Sierra Nevada Conservancy have a long and successful record of working with environmental groups to create mutually beneficial solutions in project implementation.

An additional area where the State will work with a collaborative subject matter expert is in the creation of a pay-for-performance system associated with forest and watershed work. A key goal of the Program is to find ways to monetize aspects of forest and watershed work to attract investment capital and create lasting job opportunities for rural residents. In short, the goal is to develop a new model to generate revenue via resource stewardship in the forest and watershed. Blue Forest Conservation developed a model to realize this type of system and provided input on this application. Pending award and a competitive procurement process, Blue Forest Conservation or a similar subject matter expert will help navigate the best direction.

Additional Documentation

This BCA overview narrative is supported by the full Earth Economics BCA workbook, which includes the full calculations for the Program. The 'NDRC Format' tab presents all of the data outlined in Appendix H with respect to the table outlining all BCA costs and benefits. Earth Economics has also provided a companion document to this workbook, entitled 'State of California: Benefit-Cost Analysis Methods and Assumptions' which is included below.

As mentioned previously, Earth Economics also performed an economic impact analysis demonstrating additional values and benefits of the Program using the IMPLAN program, the results of which are very notable, but not calculated into the BCA. A companion document outlining methodologies and assumptions for this economic impact analysis is also included below. Additional supporting documentation that contributed to developing the budgets and performing the BCA calculations for Forest and Watershed Health, Community Resilience Centers, and Biomass Facility and Wood Products Campus can be found here in the BCA Supporting Documents sections of the page.

EARTH ECONOMICS

State of California:
Benefit-Cost Analysis Methods and Assumptions

October 23, 2015

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About this Document

The purpose of this document is to provide additional detail regarding assumptions, calculations and supporting references for benefits and costs described in the BCA summary tables and accompanying spreadsheet. The methods are organized according to the three program areas: Forest and Watershed Management, Biomass and Wood Products, and Community Resilience Centers.

Contents

State of California - Benefit Cost Analysis Methods 1

About this Document..... 2

Program 1: Forest and Watershed Health..... 3

Overview..... 3

Assumptions 3

Ecosystem Service Valuation Methods 6

Carbon Storage Valuation Methods..... 11

Program 2: Biomass and Wood Products Facility 15

Program 3: Community Resilience Centers 16

California Conservation Corps and Head Start..... 16

Jobs Creation..... 18

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Program 1: Forest and Watershed Health

Overview

The Forest and Watershed Health Program seeks to implement a series of fuel reduction and reforestation activities intended to restore the forest to a more natural and sustainable condition that will reduce future wildfire magnitude and impact. The BCA team included leadership and subject matter experts in firefighting, fire science, damage assessment, ecological economics, and wildfire mitigation. Agency partners included CAL FIRE, the U.S. Forest Service, and the California State Office of Planning and Research.

Assumptions

Model 30-Year Fire

Modeling future fire risk and damages is inherently challenging due to the variability of fire behavior from event to event and the highly unpredictable nature of damages across the burned area. Unlike flood risk that can be modeled quite precisely using elevation and rainfall data to draw a clear boundary of damages from various event magnitudes, fire causes damages that are patchy and difficult to forecast.

The project team elected to model a large-scale fire based on past experience and future climate, fuel, and population projections. This model event, called the "Model 30-Year Fire," is a major fire of similar magnitude (150,000 acres) to the 2013 Rim Fire (257,000 acres). Since a 30-year event is a statistical construct, the actual fire could occur at any time during the planning period or beyond. The team then associated a range of potential costs and benefits associated with such a fire to test the value of mitigation measures.

Analysis of this frequency and magnitude of fire leads to a conservative estimate of future damages because the project team has not included costs and damages expected from smaller, more frequent events that will also occur over the 30-year period. In addition to the Rim Fire, over the past 20 years, the Stanislaus National Forest has experienced 15 fires, consuming a total of 30,500 acres and incurring $26 million in firefighting costs alone.

Action vs. No-Action

The "No-Action" scenario (business-as-usual) represents fire size, intensity and damages for a Model 30-Year event that will occur if the forest receives modest fuel reduction treatment over the planning period. In this scenario the fire event is anticipated to cover 150,000 acres within the Rim Fire footprint. The "With-Action" scenario represents a scenario in which the U.S. Forest Service and CAL

FIRE undertake aggressive management activities, and the same Model 30-year event is reduced in area, intensity and damages by approximately 30% (see next paragraph "Benefit of Mitigation Measures" for more detail). **The difference between the No-Action and With-Action scenarios represents the benefit of the proposed mitigation activities**.

Benefit of Mitigation Measures

Though fire behavior is unpredictable, experts at CAL FIRE and U.S. Forest Service believe that strategically placed fuel breaks and ongoing biomass removal activities proposed in this application provide firefighters and residents with critical opportunities to slow fire spread, keep fire from reaching high fuel areas, and protect structures. This strategic mitigation is predicted to reduce fire size and damages by 30% with treatment of a relatively small area.

Demographic and Community Impacts

The behavior of each fire dictates the scale of evacuations and the potential for structure damage and loss. The model assumes that 6 communities, each with approximately 1,000 residents, will be at risk and may require evacuation. The 'With Action' scenario results in 1,800 fewer resident evacuations and 30% less structure loss.

Casualties and Fatalities

Fighting fire in rugged terrain and evacuation of a high number of residents yields a variety of injuries. However detailed records from past fires are not available describing the injuries and treatment of firefighters or residents. As a conservative estimate for the BCA, a reduction of 50 injuries is projected due to the reduction in wildfire size. The majority of injuries (40) are reflected in the Value of Statistical Life definitions as AIS-1: Minor. The others 10 injuries are distributed through the other injury levels with one death (AIS-6) avoided in the With-Action scenario.

Basal Area Loss

In the 30-Year Model Fire, in both No-Action and With-Action scenarios, damage is described by various percentages of Basal Area Loss, divided into four categories: 0%, 0-25%, 25-75%, and 75%-100%. The higher percentage indicates a more intense and complete burn of the area. While it is likely that mitigation measures will change the proportions in each category the data was not convincing enough to change the profile in the With-Action scenario. Therefore the BA Loss proportions in both the No-Action and With-Action scenarios remain the same.

Average Cost of Firefighting

Historical cost per-acre data was analyzed for the Stanislaus National Forest to determine firefighting costs for a Model 30-Year Fire. This data indicates, as would be expected, that the per-acre cost of fighting a fire is inversely proportional to the size of the fire due to the high activation costs for any

event. The costs vary from $4,600/acre to $505/acre with one outlying event recorded at $125,000/acre for a small event. The average cost of $571 per acre is used as the cost for the Model 30-Year event and seems fitting for the scale of the predicted fire.

Value at Risk – Infrastructure

Just like the Rim Fire, future fires will damage many different types of infrastructure in the forest, from roads and trails to campgrounds and hydroelectric stations. The U.S. Forest Service has developed a tool called Value-At-Risk (VAR) to make a post-fire assessment of infrastructure damage and costs experienced during a fire and for as many as 10-years after the event from heavy rains, wind storms, and flooding that may cause significant further damage. The Rim Fire VAR and input from the local Burned Area Emergency Response (BAER) coordinator was used to determine the scope of damages expected in each of the infrastructure categories. Mitigation measures are predicted to reduce fire damages in each of these areas by 30%.

References Used to Build Scenario

- Batker et al. 2013. Economic Impacts of the 2013 Rim Fire on Natural Lands. Earth Economics
- Ecological Restoration Institute. 2013. Efficacy of hazardous fuel treatments: A rapid assessment of the economic and ecologic consequences of alternative hazardous fuel treatments: A summary document for policy makers. Northern Arizona University. 28 pp.
- Cleetus and Mulik. 2014. Playing with Fire: How Climate Change an Development Patterns are Contributing to the Soaring Costs of Western Wildfires. Union of Concerned Scientists.
- Crook et al. 2014. 2013 Rim Fire: Fuel Treatment Effectiveness Summary. U.S. Forest Service.
- Lydersen, J. M., North, M. P., & Collins, B. M. 2014. Severity of an uncharacteristically large wildfire, the Rim Fire, in forests with relatively restored frequent fire regimes. Forest Ecology and Management, 328, 326-334.

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Ecosystem Service Valuation Methods

The No-Action and With-Action scenarios described above were used to model the avoided loss of ecosystem services. The following areas and Basal Area Loss data were used in the model:

Table 1 - Description of Fire Scenarios

Burn Intensity	No Action Distribution	No Action Acreage	With Mitigation Distribution	With Mitigation Acreage	Avoided Damage Total Acres	Avoided Damage Annual Acres
BA Loss - 0	20%	30,000	20%	21,000	9,000	300
BA Loss 0-25	20%	30,000	20%	21,000	9,000	300
BA Loss 25-75	30%	45,000	30%	31,500	13,500	450
BA Loss 75-100%	30%	45,000	30%	31,500	13,500	450
BA Total	**100%**	**150,000**	**100%**	**105,000**	**45,000**	**1,500**

The area of each vegetation type that fell into each Basal Area Loss category was estimated. Because the fire models did not provide estimates at this level of detail, Earth Economics assumed that the BA Loss distribution by vegetation type due to the fires in both the No-Action and With-Action scenarios would proportionally be the same as that previously measured in the Rim Fire as shown in Table 2 and Table 3.

Table 2 – No-Action Scenario - Area of each Land Cover by Basal Area Loss (%)

	Area (Acres)			
Land Cover	**0% BA Loss**	**0-25% BA Loss**	**25-75% BA Loss**	**75-100% BA Loss**
Grassland	1,165	1,595	3,752	4,919
Herbaceous Wetland	55	85	131	89
Lake	148	64	57	11
Riparian	37	28	31	21
River	52	22	26	4
Shrub	1,211	2,062	4,834	8,925
Forest Broad Leaf	4,224	5,999	8,697	8,761
Forest Coniferous	23,108	20,145	27,472	22,270
Total	**30,000**	**30,000**	**45,000**	**45,000**

Table 3 – With-Action Scenario - Area of each Land Cover by Basal Area Loss (%)

	Area (Acres)			
Land Cover	**0% BA Loss**	**0-25% BA Loss**	**25-75% BA Loss**	**75-100% BA Loss**
Grassland	816	1,117	2,626	3,443
Herbaceous Wetland	38	59	92	63
Lake	104	45	40	8
Riparian	26	20	22	15
River	36	16	18	2
Shrub	848	1,444	3,384	6,248
Forest Broad Leaf	2,957	4,199	6,088	6,133
Forest Coniferous	16,176	14,101	19,230	15,589
Total	**21,000**	**21,000**	**31,500**	**31,500**

The definition for each land cover type is provided in Table 4.

Table 4 - Land Cover Definitions

Land Cover	**Description and Layer(s) Used**
Grassland/Meadow	Includes annual and perennial grasslands that dominate major regions around coniferous forests.
Herbaceous Wetland	Includes wetlands dominated by herbaceous meadow vegetation. Includes areas where total herbaceous wetland vegetation coverage is greater than 20%.
Shrub	Contains areas dominated by shrubs less than 5 meters tall. This class includes chaparral shrubs and mixed montane shrubs.
River	Includes stream and creek systems and sometimes areas of open water.
Lake	Includes areas of open water, generally with less than 25% cover of vegetation or soil.
Riparian	Riparian areas alongside riverine and wetland regions. Exists through various altitudes
Forest (Broad Leaf and Mixed)	Includes a mixture of aspen, blue oak woodlands, and montane hardwoods that occur sporadically throughout National Parks Service and U.S. Forest Service lands.
Forest Coniferous	Include many conifer dominated vegetation types such as Blue Oak-Foothill Pine, Closed-Cone Pine-Cypress, Douglas Fir, Jeffrey Pine, Lodgepole Pine, Ponderosa Pine, Red Fir, Sierran Mixed Conifer, and Mixed Montane Hardwoods Conifers.

Using this land cover – acreage data above, Benefit Transfer Methodology was used to estimate the total ecosystem service value loss in both the No-Action and With-Action scenarios. Benefit Transfer Methodology is a federally accepted economic valuation methodology that utilizes local values where possible, and previous valuation studies of similar goods or services in comparable locations where local values are not available. These valuation studies each utilize one of eight primary valuation techniques, which include market pricing, cost avoidance, replacement cost, travel cost and contingent valuation. (See BCA Workbook for full references.)

In 2013, Earth Economics created a dataset of economic values that was used to estimate damages to ecosystem services due to the Rim Fire. The resulting study[a] was used to support the State of California's application to FEMA for a Major Disaster Declaration. This same dataset was used for this study.

Transferred values from the Rim Fire study, which were in 2012 dollars, were converted to 2015 dollars per acre per year, representing the annual flow of value generated by a single ecosystem service on a specific land cover during each calendar year. Combining the available ecosystem service values (water regulation, habitat, recreation, etc.) for a single land cover yields a total value for that land cover in dollars per acre per year.

Monetary values were calculated for 10 out of 18 identified categories of ecosystem services identified. Eight categories of ecosystem services damaged by the fire were not estimated due to lack of peer-reviewed comparable data. The ten environmental benefits valued were: (1) air quality; (2) carbon sequestration; (3) flood protection; (4) erosion control; (5) biological control; (6) water filtration; (7) pollination; (8) habitat and biodiversity; (9) property and aesthetic values; and (10) recreational values. The eight land cover types were: (1) grassland/meadow; (2) herbaceous wetland; (3) shrub; (4) river; (5) lake; (6) riparian; (7) forest broad leaf and mixed forest; and (8) coniferous forest.

Table 5 summarizes the range of values for each land cover type, expressed in $/acre/year:

[a] Batker, D. Christin, Z., Schmidt, R., de la Torre, I., 2013. The Economic Impact of the 2013 Rim Fire on Natural Lands. Earth Economics, Tacoma, WA.

Table 5 - Value by Land Cover

Land Cover	ES Value Low (1) ($/acre/year)	ES Value High (1) ($/acre/year)
Grassland	$2,384	$5,397
Herbaceous Wetland	$1,909	$75,167
Lake	$1,533	$46,946
Riparian	$731	$5,058
River	$176	$39,179
Shrub	$24	$1,672
Forest Broad Leaf	$210	$11,738
Forest Coniferous	$974	$4,940

Ecosystem service functions are impaired or enhanced by changes in land cover type or quality. Forest areas, immediately after a fire, for example, have less biodiversity and less water filtration capacity than an untouched forest. BA Loss is a coarse, rapid assessment of real fire damage to vegetation. Based on expert judgment, a coefficient was adopted to represent the loss of ecosystem services as a function of BA Loss. Table 6 provides estimates of the estimated loss in ecosystem service function with each category of BA Loss. The relationship between BA Loss and ecosystem service function capacity requires further study. Each ecosystem will have different function losses and will regain (or not regain) those functions over time at different rates.

Table 6 - Ecosystem Service Capacity Lost as a function of BA Loss

BA Loss	Ecosystem Service Capacity Lost
0%	0%
0 - 25%	10%
25 - 75%	50%
75 - 100%	90%

Ecosystem service losses for the fire in each scenario were estimated by multiplying the acreage of each unique landcover/BA Loss combination in the No-Action scenario (Table 2) and With-Action scenario (Table 3) by the value range for that landcover in Table 5, and then weighting each value according to the coefficients associated with the BA Loss (Table 6). Total losses for each fire were then estimated.

Results indicate that damages to ecosystem services in the No-Action scenario would range from approximately $56 million to $411 million while damages to ecosystem services in the With-Action scenario would range from approximately $39 million to $287 million. This result suggests the With-Action scenario would avoid between approximately $17 million and $123 million in damages to ecosystem services compared with the No-Action scenario. Table 7 summarizes these avoided damages in a one-time 30-year event, and average avoided damages over 30 years. The average value was used for the BCA analysis. The average value is considered a conservative estimate given that only a subset of ecosystem services was valued for each land cover.

Table 7 - Avoided damages to ecosystem services in With-Action scenario

	Low	High	Average
Avoided damages in a 30 year event	$16,726,458	$123,179,835	$69,953,147
Annual Average Avoided Damages	$557,549	$4,105,995	$2,331,772

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Carbon Storage Valuation Methods

Stored carbon biomass provides economic value by contributing to climate stability. In this study, the economic value of avoided carbon emissions was calculated for the Model 30-Year fire in the With-Action scenario compared with the No-Action scenario.

CalFIRE and U.S. Forest Service staff modeled these scenarios and provided results to Earth Economics. Results included total acreage burned by BA Loss for a typical 30 year event under both scenarios. Table 8 provides a summary of these results.

Table 8 - Description of Fire Scenarios

Burn Intensity	No Action Distribution	No Action Acreage	With Mitigation Distribution	With Mitigation Acreage	Avoided Damage Total Acres	Avoided Damage Annual Acres
BA Loss - 0	20%	30,000	20%	21,000	9,000	300
BA Loss 0-25	20%	30,000	20%	21,000	9,000	300
BA Loss 25-75	30%	45,000	30%	31,500	13,500	450
BA Loss 75-100%	30%	45,000	30%	31,500	13,500	450
BA Total	**100%**	**150,000**	**100%**	**105,000**	**45,000**	**1,500**

Next, the area of each vegetation type that fell into each BA Loss category was estimated. Because the fire models did not provide estimates at this level of detail, Earth Economics assumed that the BA Loss distribution by vegetation type due to the fires in both the No-Action and With-Action scenarios would proportionally be the same as that experienced in the Rim Fire. Results of this assumption are provided in Table 9 (No-Action) and Table 10 (With-Action) below.

Table 9 – No-Action Scenario - Area of each Land Cover by Basal Area Loss (%)

	Area (Acres)			
Land Cover Type	**0% BA Loss**	**0-25% BA Loss**	**25-75% BA Loss**	**75-100% BA Loss**
Aspen-Birch	2,818	4,051	6,048	6,055
Chaparrals	1,221	2,070	4,846	8,932
Douglas Fir	532	420	620	403
Lodgepole Pine	1,573	1,337	2,008	1,230
Mixed Conifer	19,298	16,417	21,461	17,644
Montane Riparian Meadows	1,230	1,686	3,893	5,012
Ponderosa Pine	2,994	3,734	5,670	5,502
Western Oak	334	284	453	221
Total	**30,000**	**30,000**	**45,000**	**45,000**

Table 10 - With-Action Scenario - Area of each Land Cover by Basal Area Loss (%)

	Area (Acres)			
Land Cover Type	**0% BA Loss**	**0-25% BA Loss**	**25-75% BA Loss**	**75-100% BA Loss**
Aspen-Birch	1,973	2,835	4,234	4,238
Chaparrals	854	1,449	3,392	6,253
Douglas Fir	372	294	434	282
Lodgepole Pine	1,101	936	1,406	861
Mixed Conifer	13,509	11,492	15,023	12,351
Montane Riparian Meadows	861	1,180	2,725	3,508
Ponderosa Pine	2,096	2,614	3,969	3,851
Western Oak	234	199	317	155
Total	**21,000**	**21,000**	**31,500**	**31,500**

Dollar values were estimated for each ton or carbon lost into the atmosphere for both the No-Action and With-Action scenario. The low value ($12.83 per ton CO_2) used was the market value of carbon in the California cap-and-trade market.[b] The high value ($51.34 per ton CO_2) used was the EPA's 2015 estimate for the social cost of carbon.[c] The social cost of carbon represents the net economic impacts

[b] Accessed on October 6, 2015 at http://calcarbondash.org/

[c] Environmental Protection Agency, 2013 (revised July 2015). Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866 EPA's. Available at:

(such as human health impacts, lower agricultural yields, and increased storm damages) of each additional amount of CO_2 that has been released into the atmosphere. It should be noted that carbon released during a wildfire may be sequestered again with future regrowth of the forest, but while in the atmosphere will contribute to climate change impacts, which form the basis of the social cost of carbon values used.

Next, studies were used to estimate the carbon stored in each vegetation type. Table 11 provides a summary of carbon storage by vegetation type, along with an estimate for the dollar value of carbon stored in an acre of each vegetation type, based on the $ per ton estimates used. Note that carbon values are expressed in $ per ton CO_2, while forest carbon storage values are expressed in tons C stored (not CO_2). A conversion was made to account for the different measures.

Table 11 - Carbon Storage by Vegetation Type

Land Cover Type	Low Non-Soil Carbon Biomass (tC/acre)	High Non-Soil Carbon Biomass (tC/acre)	Low Cost of Carbon Emissions ($/tC)	High Cost of Carbon Emissions ($/tC)	Low Value of Carbon Storage ($/acre)	High Value of Carbon Storage ($/acre)
Aspen-Birch	75	75	$47	$188	$3,523	$14,099
Chaparrals	15	18	$47	$188	$699	$3,386
Douglas Fir	85	85	$47	$188	$4,003	$16,020
Lodgepole Pine	49	49	$47	$188	$2,315	$9,264
Mixed Conifer	112	112	$47	$188	$5,267	$21,076
Montane Riparian Meadows	65	77	$47	$188	$3,049	$14,487
Ponderosa Pine	52	52	$47	$188	$2,437	$9,752
Western Oak	106	106	$47	$188	$4,968	$19,878

Carbon storage impaired or enhanced by changes in land cover type or quality. Forest areas, immediately after a fire, for example, store less carbon than the same forest areas before the fire. BA Loss is a coarse, rapid assessment of real fire damage to vegetation. Based on expert judgment, a coefficient was adopted to represent the loss of carbon storage capacity as a function of BA Loss. Table 12 provides estimates of the estimated loss in carbon storage capacity with each category of BA Loss.

Table 12 - Ecosystem Service Function Capacity at BA Loss

BA Loss	Carbon Storage Capacity Lost
0%	0%
0 - 25%	10%
25 - 75%	50%

http://www3.epa.gov/climatechange/EPAactivities/economics/scc.html. The Social cost of carbon used was at 3% discount rate for the year 2025 ($51), converted from 2014 dollars to 2015 dollars ($51.34).

75 - 100%	90%

The cost of carbon storage losses for the fire in each scenario were estimated by multiplying the acreage of each unique landcover/BA Loss combination in the No-Action scenario (Table 9) and With-Action scenario (Table 10) by the value range for that landcover in Table 11, and then weighting each value according to the coefficients associated with the BA Loss (Table 12). Total losses for each fire were then estimated.

Results indicate that costs due to carbon emissions in the No-Action scenario would range from approximately $238 million to $974 million, while costs due to carbon emissions in the With-Action scenario would range from approximately $167 million to $682 million. This result suggests that With-Action scenario would avoid damages of $71 million to $292 million compared with the No-Action scenario. Table 13 summarizes these avoided damages in a one-time 30-year event, and average avoided damages over 30 years.

Table 13 - Total Avoided Carbon Loss

	Low	High	Average
Total Avoided Damages	**$71,383,842**	**$292,075,106**	**$181,729,474**
Average Annual Avoided Damage	**$2,379,461**	**$9,735,837**	**$6,057,649**

Program 2: Biomass and Wood Products Facility

The Biomass Program proposes to build a 3MW biomass plant along with a facility to process and sell value-added wood products including compost, biochar, firewood, and fencing. The biomass plant will produce approximately 2.55MW of power (i.e. a 3MW plant running at 85% efficiency) to be sold into the local electrical grid. Ultimately, this program seeks to offer an environmentally preferred alternative to open pile wood burning, the typical practice today, while creating revenue streams that will help to fund operations and biomass collection.

The BCA team for this analysis included leadership and subject matter experts in biomass facility design, fire mitigation measures, ecological economics, and leadership from the U.S. Forest Service, CalEPA, CalFIRE and the Governor's Office of Planning and Research. Since the program is still in conceptual design, engineering metrics and best practices were derived from other biomass facilities operating around the State of California and research conducted throughout the nation. Revenue estimates for wood products are based on current pricing in the county. When the program moves forward, the next step will be to conduct in-depth siting and feed stock analysis that will provide more detail on both benefits and costs.

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Program 3: Community Resilience Centers

The Community Resilience Center Program (CRC) proposes to build two multipurpose community centers, one each in Groveland and Tuolumne City, to serve as evacuation sites during future fires, floods and other adverse events. On a daily basis the CRCs will provide a wide variety of community services from community college classes to commercial kitchen rental space and satellite offices for community services.

The BCA team for this analysis included experts from the Tuolumne County Economic Development Authority, California Conservation Corps, California Department of Housing and Community Development, and the Deputy County Administrator of Tuolumne County. Benefits and costs associated with these facilities were determined using a number of approaches including comparison with similar programs operating elsewhere in the county, review of local demographics, and best practices from other community centers around the nation.

Many of the benefits could not monetized at this stage of planning but can be refined as more programmatic detail becomes available. Many of the CRC's disaster and evacuation-related benefits could not be monetized because, though there is strong anecdotal evidence of a need for these services, quantities and values are not yet available. As an example, the CRCs will have capacity to accept pets, horses, and other animals during an evacuation. This capacity will provide obvious benefits for the animals but also is expected to speed human evacuation because residents will not feel the need to stay behind with their pets. The result will be more efficient evacuation and reduced injury risk but data is not available to quantify this effect. Other benefits include services for emergency responders (laundry, kitchen, etc.) that, again, will provide a benefit to these users during a disaster but are challenging to quantify. All of these benefits and more are described qualitatively in the narrative section of the BCA Worksheet for this application.

California Conservation Corps and Head Start

Two major programs will be housed at the Groveland CRC, the California Conservation Corps (CCC) and Head Start. These programs have both been shown to provide critical, life-long benefits to young adults and pre-school children, respectively. The benefits of these programs are challenging to monetize. First, the CCC will create between 15 and 45 job opportunities into the community for their training and work program. The CCC program reports substantial long-term benefits for participants, such as community involvement, and environmental training and awareness, but those benefits have not been documented in detailed, dollar-based terms. In addition, the restoration work that these teams will do will be largely funded by federal dollars (HUD and/or U.S. Forest Service), therefore inclusion within the BCA would expose an employment transfer concern from a federal perspective.

So, for now, this program has been included only as a qualitative benefit and has not been included in the ratio calculation. Further research will help to better capture and report the full social and economic value of this program to the community and participants.

The Head Start is a similarly important program that is purported to have many long-term benefits for infants, toddlers, and preschoolers who attend. Analysis has indicated that every federal dollar invested in programs similar to Head Start shows a $4 to $11 dollar return to society as represented by improved productivity (education, jobs, etc.), reduced social cost (crime) of participants, and other benefits. Because these benefits are a result of federal investment and may expose a transfer issue, and the fact that many of these benefits occur beyond the 30 year analysis period for this application, these values were not included in the BCA.

EARTH ECONOMICS

Jobs Creation

From a Benefit Cost Analysis perspective, the benefit of a job created is not the full value of that job but the difference between the new job and the employee's next best opportunity. As an overly simplified example, if skills training allows an employee to jump from $15 to $17 per hour then the benefit would be represented by the $2 difference. For this reason it is quite complex to identify and quantify this benefit. Furthermore, from a federal perspective, a job created by a federal investment cannot be counted in a benefit-cost analysis because the federal grant would create employment somewhere else if not in one's community of interest.

Regardless of these considerations, jobs in small, rural communities are critical to build a robust economy and provide many personal benefits for those hired. Table 14 below indicates the ongoing jobs (i.e. not including construction or temporary mitigation jobs) that will result from the investments in this proposal.

Table 14 – Ongoing Job Creation due to Proposed Investments

Description	Number	Annual Salary	Total Annual Payroll
Seasonal CCC Corpsmembers	45	$13,440	$604,800
Seasonal CCC Evening Duty/Kitchen	1	$18,000	$18,000
Headstart Teachers	7	$35,000	$245,000
CRC Staff	4	$30,000	$120,000
Operations Staff	6	$40,000	$240,000
Biomass Collection Staff (8 Months/Year)	8	$30,000	$240,000
Totals	**71**		**$1,467,800**

EARTH ECONOMICS

State of California:
Economic Impact Analysis Methods and Assumptions

October 23, 2015

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EARTH ECONOMICS

Economic Impact Analysis

While Benefit-Cost Analysis addresses whether society is better off by performing an action, Economic Impact Analysis (EIA) addresses how an economy is likely to change as a result of an action – in this case investing significant capital into Tuolumne County to implement these programs. Since these two forms of analysis use similar data and are often confused, it is important to present them separately.[a] Furthermore, The White House/OMB ***Circular A-94: Memorandum for Heads of Executive Departments and Establishments*** provides guidelines for benefit-cost analysis of federal programs. The Circular indicates that output multipliers should not be included benefit-cost analysis. Thus, an EIA has been conducted and included here separately.

The EIA forecasts the flow of money due to an investment into the primary industry receiving funds (direct effects), the primary industry's network of suppliers (indirect effects), and local spending due to increased (or decreased) income for workers within those industries. The EIA is an important tool for understanding the overall effect of an investment or policy change within the local economy.

This EIA was completed using IMPLAN, a widely used economic analysis tool that was originally developed in a partnership between the University of Minnesota and the U.S. Forest Service and is now a product of MIG, Inc. IMPLAN uses input-output analysis with regionally specific multiplier models. The analysis team used a 2014 dataset specific to Tuolumne County, California, which was purchased from MIG, Inc. IMPLAN version 3.1.1001.12 was used to analyze the data and run the EIA, a software that can be downloaded for free on IMPLAN's website, www.implan.com.

IMPLAN does not include an industry profile for the types of activities analyzed in the Forest and Watershed Health Program. In 2014, Headwaters Economics conducted an analysis of the Economic Impacts of Restoration in Custer and Lemhi Counties, Idaho.[b] Headwaters Economics developed industry profiles for restoration that are unique to each type of restoration project. The same industry profiles have therefore been applied to the Forest and Watershed Management Activities in this analysis.

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[a] Transportation Benefit Cost Analysis. http://bca.transportationeconomics.org/home/bca-vs-economic-impact-analysis

[b] Headwaters Economic. 2014. The Economic Impacts of Restoration: Custer and Lemhi counties, Idaho. http://headwaterseconomics.org/wphw/wp-content/uploads/Idaho_Restoration_Report.pdf